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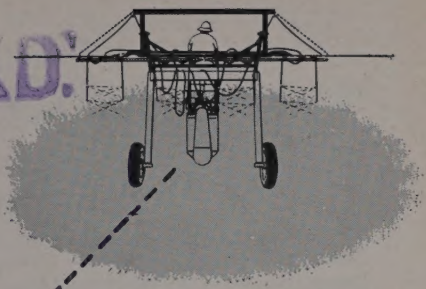
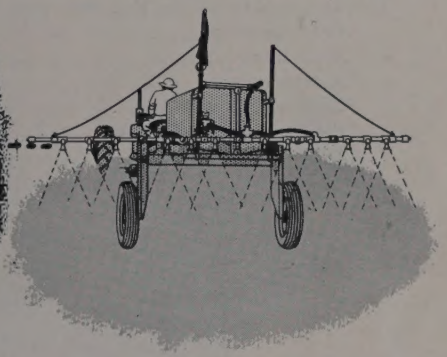
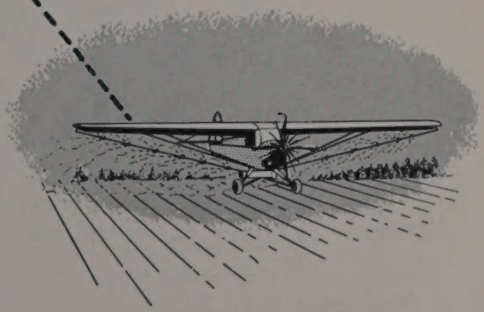


The European Corn Borer and Its Control





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The European Corn Borer and Its Control

Prepared by Entomology Research Branch, Agricultural Research Service

The European corn borer [1] has become one of our most destructive pests of corn. Since it was discovered in Massachusetts in 1917, it has spread westward and southward over a large part of the important corn acreage east of the Rocky Mountains (fig. 1). During the period 1942–51 it caused an estimated annual loss of $80½ million in damage to grain corn and $3½ million in damage to sweet corn in the United States.

This pest attacks all types of corn

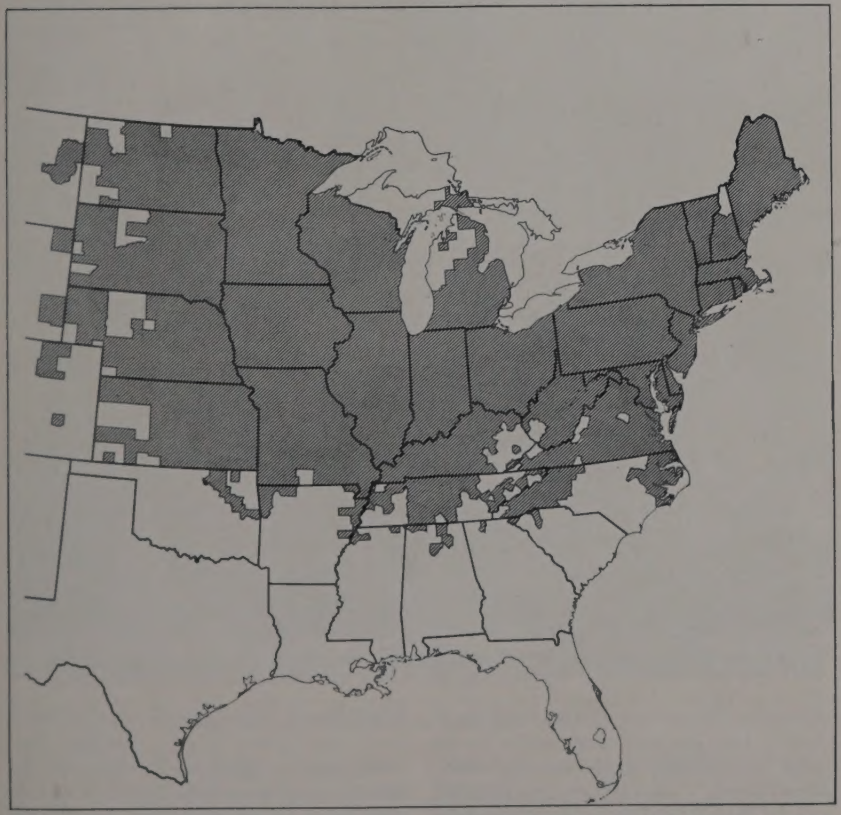

FIGURE 1.—Area in the United States known to be infested by the European corn borer in 1954.

[1] *Pyrausta nubilalis.*

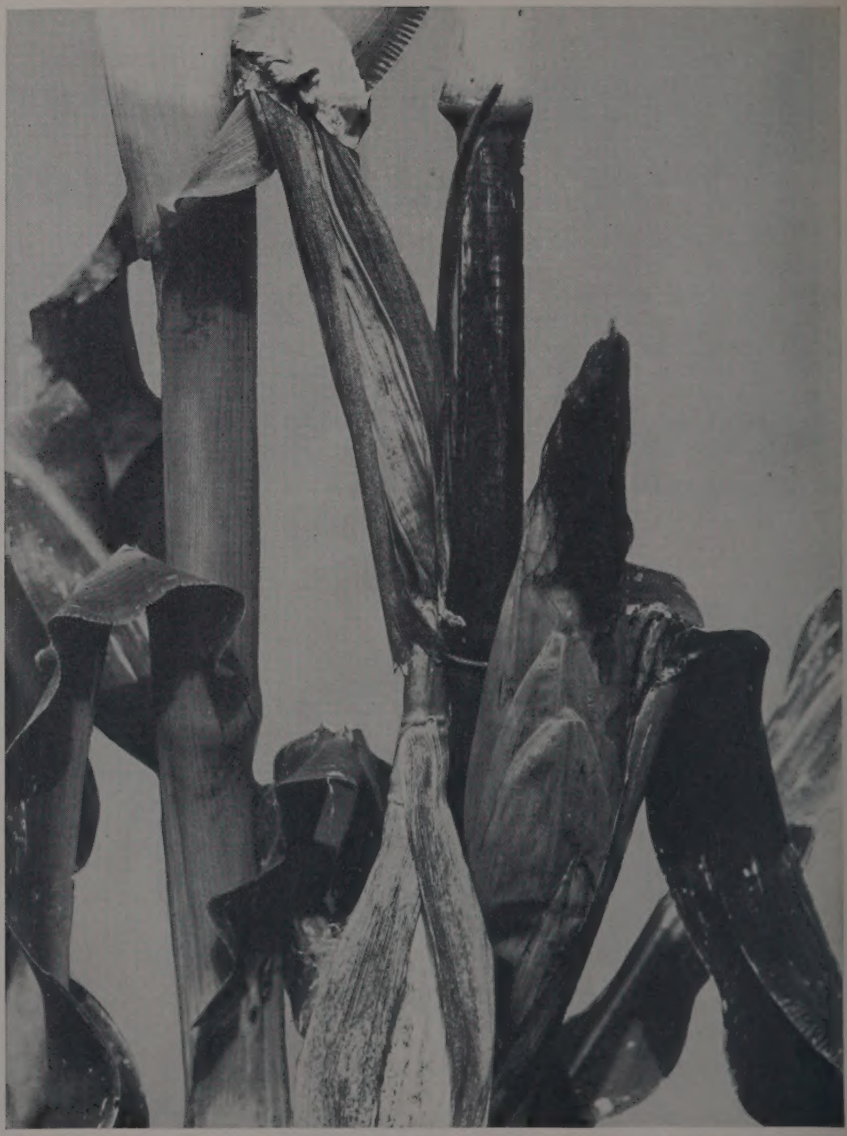

FIGURE 2.—European corn borer damage to corn plant. Note heavy leaf feeding and ear broken over and dried prematurely as a result of boring in shank.

and also infests some of the common weeds and grasses that grow in or near cornfields, such as pigweed, smartweed, cocklebur, barnyard grass, lambsquarters, foxtail, and panic grass. It also attacks such crops as sorghums, soybean, millet, buckwheat, oats, potato, and pepper, and the flower plants dahlia, cosmos, aster, gladiolus, chrysanthemum, zinnia, and hollyhock. Over 200 kinds of plants have been found infested, although many of them serve as shelter rather than as food.

FIGURE 3.—Sweet corn severely damaged by European corn borer. Frass on stalks is evidence of extensive tunneling by larvae.

The number of annual broods of the corn borer varies with latitude but is largely influenced by weather. Except in the more northern areas, where only one brood usually occurs, a large proportion of the population normally is two-brooded. In the extreme southern part of the infested area there may be a partial third brood.

NATURE OF INJURY

European corn borer damage is caused by the larvae feeding in and on various parts of the corn plant. Where two broods of the insect occur, the larvae of the first brood cause the greater reduction in yield because of their attack on the plants in the early stages of development. Second-brood borers may be responsible for extensive stalk breakage and ear dropping even though they do not reduce the yield appreciably.

FIGURE 4.—Stalk and ear shank cut open to show European corn borer larvae and their feeding. Boring in the shank causes ear to break off and drop to the ground.

Leaf feeding that results in the destruction of the leaf surface and breakage of the midribs causes some reduction in yield (fig. 2). Stalk tunneling weakens the plant and starves the ear, thus reducing yield (fig. 3). The tunneling also exposes the plant to disease organisms that cause stalk and ear rots. Stalks thus weakened break easily, making harvesting more difficult and expensive.

Ears are damaged by the larvae feeding on the silks, kernels, and cobs, and by their boring in the shanks (fig. 4). Shank injury may cause poor development and serious dropping of the ears before they can be harvested. In late-planted corn, ears that have their shanks badly damaged by the second-brood corn borer are apt to be chaffy (fig. 5). Chaffiness is also common in ears from plants that have broken over below the ear as a result of first-brood infestation. Ear damage to sweet corn is of special concern to growers of canning and market garden corn (fig. 6).

It is easy to detect corn borer injury to corn. If the infested plants are in the whorl stage, look for small holes and elongated chewed areas in the leaves caused by feeding of the young larvae before the leaves unfolded. At time of tasseling, search for young larvae feeding in the tassel buds or tunneling in the tassel stem or its branches. This tunneling frequently causes the stems to break over (fig. 7) and sawdustlike borings to appear at the breaks.

Later in the season, examine the leaf sheaths, or collars, for signs of borer feeding, and the stalk, especially behind the sheaths, for holes and sawdustlike borings where the larvae have entered to tunnel up and down the stalk. Feeding by the borers at the base of the leaves, often in the midribs, sometimes causes the leaves to break

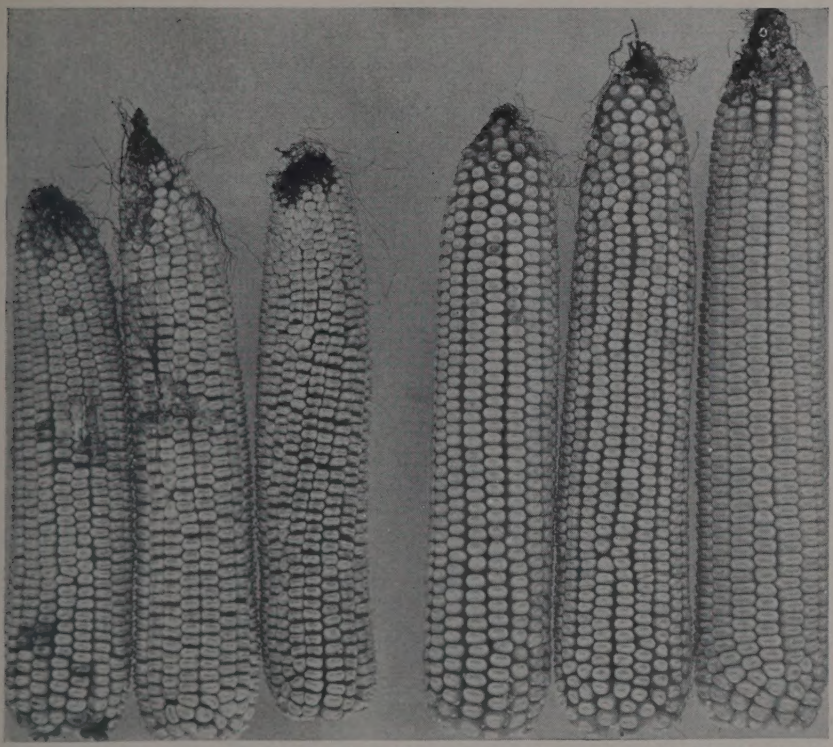

FIGURE 5.—Chaffy ears on left caused by European corn borer damage to shanks of late-planted corn. Sound ears on right are from plants without shank infestation.

FIGURE 6.—Ears of sweet corn severely damaged by European corn borer.

FIGURE 7.—Corn tassel broken over by European corn borer larvae.

over at that point. If the infestation occurs after pollen shedding, many of the young larvae first feed on the accumulations of pollen on the plants. When a number of large borers tunnel extensively in the stalk they weaken the plant so that it breaks over. Severely injured plants dry earlier than uninjured or slightly injured plants.

Young larvae ordinarily enter the ears near the tip, feed on the silks or on the tender portion of the husk, and then work their way into the cob and grain. However, the larger borers may enter the ears directly at the tip, base, or side, or they may bore into the ear shank.

DESCRIPTION AND SEASONAL HISTORY

The European corn borer passes the winter as a full-grown larva inside its tunnel in the stalk, stubble, or ear of corn, in weeds, or in other plant material where it has found shelter. At this time the larva is nearly an inch long and $\frac{1}{8}$ inch thick (fig. 8). The head is dark brown or black. The upper part of the body is gray to light brown or

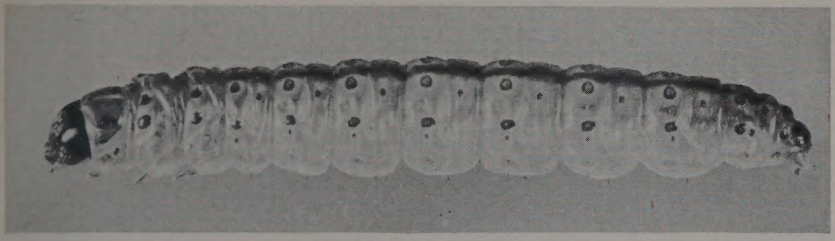

FIGURE 8.—Full-grown larva of European corn borer. Enlarged.

pink, with rows of brown spots and several brown or pink lines extending lengthwise. The underside of the body is cream colored and without markings.

In May or early June the borer spins a thin cocoon, inside of which it changes to a pupa (fig. 9). If the borer is inside a tunnel in a cornstalk it cuts a small circular opening to the surface before pupating in order to provide an exit for the future moth. When pupation occurs in midsummer, the pupa may be located in the stalk or ear or even on the leaves.

FIGURE 9.—European corn borer pupa inside cornstalk. Enlarged.

The pupa is brown and ½ to ⅝ inch long. After 10 to 14 days the moth emerges.

The female moth (fig. 10, A) has a robust body and a wing spread of about an inch. The general color is pale yellow to light brown. The outer third of the wings is usually crossed by two dark zigzag lines.

The male moth (fig. 10, B) is smaller, has a more slender body, and is darker than the female. The outer third of the wings is usually crossed by two zigzag streaks of pale yellow, and there are frequently small pale-yellow areas on the forewings.

Moths from overwintered borers emerge from late May to early July while those of the summer brood emerge in late July and in August. Soon after they emerge the females mate and lay their eggs. They hide during the day in weeds and grass or underneath the leaves of corn and other plants. In the evening and sometimes throughout the night, when weather conditions are favorable, they fly from plant to plant laying their eggs in flat, irregularly shaped masses (fig. 11). The number of eggs laid by each female varies greatly. The average is about 400, but as many as 1,900 have been observed. The moths live from 1 to 5 weeks.

The eggs of the first brood are laid in May or June and those of the second brood in late July or

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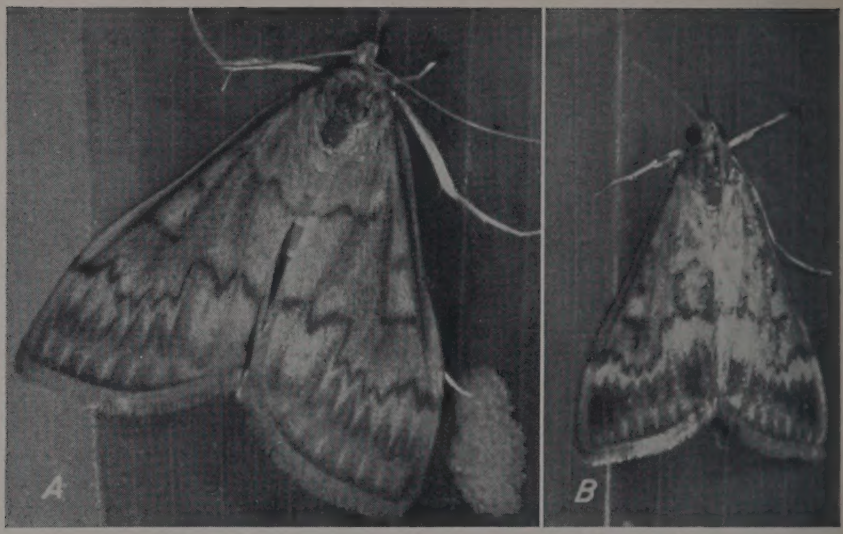

FIGURE 10.—European corn borer moths: A, Female, with egg mass on corn leaf; B, male. Enlarged. (Courtesy of Illinois Natural History Survey.)

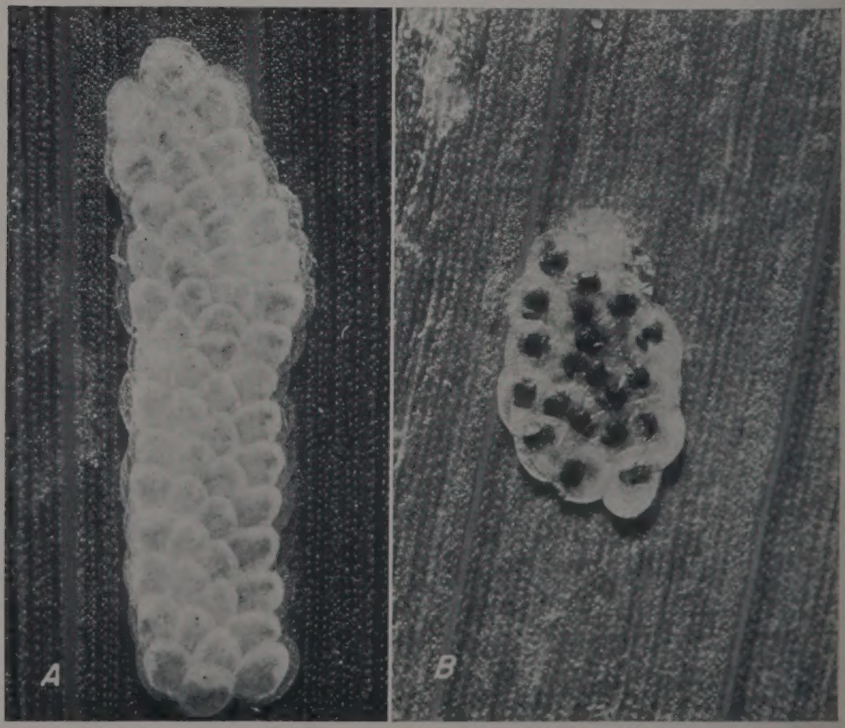

FIGURE 11.—Eggs of European corn borer: A, Soon after being laid; B, in black-head stage about ready to hatch. Enlarged.

August. They are laid principally on the under side of the corn leaves, but occasionally on the upper side of the leaf, on the stalk, or on the husk of the ear. There are usually from 15 to 20 eggs in an egg mass, although masses containing fewer or more than this number are common. The eggs, each about half the size of a pinhead, overlap one another like fish scales. They are white when first laid, later changing to pale yellow and becoming darker just before hatching (fig. 11, B), when the dark brown heads of the young borers inside can be plainly seen.

The eggs hatch in 4 to 9 days, depending on the temperature. The newly hatched borer is about $\frac{1}{16}$ inch long, and has a black head and a pale-yellow body that bears several rows of small black or brown spots. During its growth the borer changes its skin, or molts, five or six times, increasing in size with each change until it becomes full grown.

CONTROL

The habits of the European corn borer and the cultural practices employed in corn production and utilization vary in the infested area. In general, however, sound farm practices go hand in hand with effective corn borer control.

USE RESISTANT OR TOLERANT CORN HYBRIDS

Inbred lines with a good degree of resistance to first-brood infestation have been released by several State agricultural experiment stations, and are being used by the corn breeders in the development of new and better hybrids (fig. 12). Hybrids that contain three resistant lines commonly have 50 percent less borer survival than hybrids made up of three susceptible lines. Some hybrids are tolerant and produce good yields by withstanding attack by the corn borer (fig. 13). A borer-tolerant hybrid stands well

FIGURE 12.—Susceptible corn on left severely damaged by European corn borer. Resistant corn on right with little damage.

FIGURE 13.—Rows of corn on left and right tolerant to European corn borer. Center row not tolerant and badly damaged.

and holds its ears in spite of infestation and therefore can be harvested efficiently with mechanical pickers.

Plant resistant or tolerant hybrids that are adapted to your locality. Consult your State agricultural experiment station or county agent for the latest recommendations.

DESTROY OVERWINTERING BORERS

Kill as many of the overwintering borers as possible. Dead borers cannot reproduce. Plow under all crop and weed residues before the moths emerge in the spring. Bury them at least 6 inches where soil conditions permit so that little debris will be brought to the sur-

FIGURE 14.—Spring plowing as a means of European corn borer destruction.

face with later cultivation. Plow in the fall in areas where soil blowing or erosion is not a problem. Plowing itself does not kill many borers, and those that are plowed under survive and make their way to the soil surface. However, if little debris remains on the surface to provide them shelter, the larvae that crawl out of the soil perish from exposure to the weather and natural enemies. Figure 14 shows an effective job of clean plowing.

Plows now on the market are well adapted for clean plowing. If you use a rolling colter of proper size and a jointer, and attach covering wires, you can cover practically all cornstalks and trash without previous treatment. Attach three No. 9 galvanized wires, each about 12 feet long, to the plow, leaving the other ends loose. In operation the loose ends are caught by the furrow slice as it is turned over. The wires are held tightly to the top of the furrow slice by the weight of the soil on the buried ends of the wires, so that all trash is turned to the bottom of the furrow. Effective use of wires is illustrated in figure 15.

Feed infested plants to livestock as silage or fodder. Cut the plants as close to the ground as possible. Any borers that are not killed in the silage cutter will die in the silo. Chopping, husking, or shredding machines kill many borers and also make the fodder more acceptable to livestock.

ADJUST PLANTING DATES

Plant corn at the usual time for your locality—the time which your experience has shown to produce the best results. Corn planted then is likely to give the highest yields even if infested by the corn borer.

Early planted corn is usually the most severely infested. Late planted corn is likely to be heavily infested late in the season by the second brood of the corn borer, suffer stalk breakage and ear drop-

FIGURE 15.—Effective use of wires to aid in turning under cornstalks and other trash.

ping, and be difficult to harvest. It will also probably yield less and be higher in moisture content at harvesttime.

USE AN INSECTICIDE

In corn heavily infested with the European corn borer, the only practical method for preventing serious damage is to use an insecticide.

On Dent Corn

WHEN TO TREAT.—The number and timing of the treatments depend on the severity of the infestation. One well-timed treatment against the first-brood borers should be adequate to provide reasonable control. However, in a very heavily infested field, or to protect a valuable seed crop, two treatments may be needed.

If you plan a single treatment, apply the insecticide when three-fourths of the plants show evidence of recent feeding in the whorl, or 10 to 14 days after the first eggs hatch, if there are still 50 or more egg masses per 100 plants.

For a two-treatment schedule make the first application 7 to 10 days after the first eggs hatch, if at that time there are 50 or more egg masses per plant, or when three-fourths of the plants show evidence of feeding and the corn is not more than 10 to 15 days from tasseling. Make the second application 7 to 10 days after the first.

For more exact information on timing, follow recommendations of your State agricultural experiment station.

A single treatment to control a heavy infestation of second-brood borers may sometimes be advisable to prevent stalk breakage and ear dropping. Treat when the first

FIGURE 16.—Spraying for first-brood European corn borer. (Courtesy of Illinois Natural History Survey.)

eggs hatch if there are 100 egg masses per 100 plants.

WHAT INSECTICIDES TO USE.—The following treatments are recommended for control of the European corn borer:

Sprays.—Use DDT at the rate of 1½ pounds per acre. With ground equipment apply an emulsifiable concentrate in 5 to 50 gallons or a wettable powder in 15 or more gallons of water per acre. The emulsion is commonly applied at the rate of 10 gallons per acre. The quantity of concentrate or wettable powder will depend on its concentration, as given on the label. With an airplane apply an emulsifiable concentrate in 2 to 5 gallons of water per acre.

Dusts.—Use DDT at the rate of 2 pounds, or ryania at the rate of 12 to 16 pounds, per acre. A 5- or 10-percent DDT dust or a 40-percent ryania dust can be obtained ready-mixed.

WHAT EQUIPMENT TO USE.—Application of the insecticide with ground equipment has generally been more effective than with airplanes, and sprays have given better control than dusts under most conditions.

If you use a ground sprayer, equip it with a boom preferably having 2 or 3 nozzles per row and use a pressure of 40 to 150 pounds per square inch. For first-brood borer control, direct the spray into the whorl of the corn plant: for second-brood control, aim it at the ear zone.

Various types of ground sprayers are available, from low-clearance tractor-operated (fig. 16) to high-clearance self-propelled equipment (fig. 17).

You can use a row-crop duster for control of the first-brood borers. One with high air velocity and volume is most satisfactory. Use two nozzles per row adjusted 5 inches above the plants to blow the dust into the whorls.

An airplane for spraying or dusting should be equipped with spray booms with nozzles, or with dust outlets, arranged to give as even distribution as possible across the swath. The swath should be no wider than the wing span. It is important to have a flagman in the field to guide the pilot. Flight

FIGURE 17.—High-clearance sprayer for European corn borer control.

height should not exceed 6 feet, as measured from the top of the corn to the wheels of the plane. Airplane spraying should not be undertaken when the wind velocity is more than 8 miles per hour (fig. 18), or dusting when it exceeds 4 miles per hour.

On Sweet Corn

Canning and market garden sweet corn are likely to be heavily infested with the European corn borer. The use of insecticides is often essential to the production of borer-free corn. However, treatment of sweet corn is a special problem, and the timing and number of applications vary in different sections of the country.

Apply DDT or ryania at the dosages recommended for corn borer control in dent corn and with similar equipment, but make more applications. Make the first application when you find that corn borer eggs are hatching in the field, or as soon as you observe any feeding by the young borers on the plants. Follow with three additional applications at 5-day intervals.

Consult your county agent or State agricultural experiment station for exact information on the best program for treating sweet corn in your locality.

FIGURE 18.—Airplane spraying for European corn borer control.

Precautions

DDT and ryania are poisonous. Handle them with care. Follow directions on the container. Do not feed corn plants treated with DDT to dairy animals or to animals being finished for slaughter.

FIGURE 19.—Adult of *Lydella stabulans grisescens*, an important parasite of the European corn borer.

AID FROM IMPORTED PARASITES

To help control the European corn borer in the United States, insect parasites have been imported from Europe and the Orient and released by the millions over most of the heavily infested areas. Although several of the 21 kinds introduced have become established, only 4 of them have yet proved of value in reducing borer populations, and their usefulness is sometimes restricted to certain localities.

Lydella stabulans var. *grisescens*, (fig. 19), a fly that looks much like the common house fly, is the most abundant and widely effective parasite. The females deposit live maggots near corn borer larvae. The maggots penetrate the borers, feed internally, and thus kill them.

A very small black wasp known as *Sympiesis viridula* is generally distributed from Ohio to Iowa. From 5 to 10 larvae of this parasite feed externally on a single borer. Because they are so small, they are often overlooked (fig. 20).

In the Eastern States two other wasps are important parasites. *Horogenes punctorius* is black with reddish legs and about ½ inch long.

FIGURE 20.—Colony of the European corn borer parasite *Sympiesis viridula*, newly pupated.

Only one parasite develops in a single corn borer. The other species, *Macrocentrus gifuensis*, is of a light amber color. From 6 to 12 live within a borer, later coming to the outside of the destroyed borer to spin their cocoons. Both of these parasites are present in the Corn Belt, but have not increased to appreciable numbers except in very limited localities.

OTHER NATURAL ENEMIES

Several other natural enemies of the European corn borer attack the pest in this country. A number of native insects destroy a small proportion of the population. Birds, particularly woodpeckers and blackbirds, feed on corn borer larvae in the fields, and lady beetles frequently kill large numbers of corn borer egg masses and small larvae.

A fungus disease, *Beauveria bassiana*, that attacks the borer in the Orient, and a protozoan disease, *Perezia pyraustae*, originally from Europe, are both present in the United States. The former disease kills the larvae. The latter infects the eggs, larvae, pupae, and moths, and causes the moths to lay fewer eggs than normal.

LARVAE MISTAKEN FOR THE EUROPEAN CORN BORER

Several native larvae are often mistaken for the European corn borer. Some of them look much like the corn borer, and others, though very different in appearance, cause similar damage to the corn.

CORN EARWORM

The corn earworm [2] (fig. 21) injures the ears of corn similarly to the European corn borer. The earworm, however, usually confines its damage to the silks and kernels whereas the corn borer also bores

FIGURE 21.—Corn earworm feeding on silk and kernels of corn.

into the shank and cob. The corn earworm rarely bores into the stalks. Early in the summer it does often feed on the leaves in the whorl or on the emerging tassel of young plants.

The larvae of the corn earworm are about 1½ inches long when full grown and vary greatly in color, ranging from tints of green, pink, rose, yellow, and brown to almost black. They are nearly twice the size of the European corn borer.

STALK BORER

The stalk borer [3] (fig. 22) often infests corn early in the summer in some sections of the country. The larvae burrow into young plants, killing the buds, and they also bore into the stalks.

The young larvae of the stalk borer can easily be distinguished from those of the European corn borer by a dark-brown or purple band around the middle of the body

[2] *Heliothis armigera.*

[3] *Papaipema nebris.*

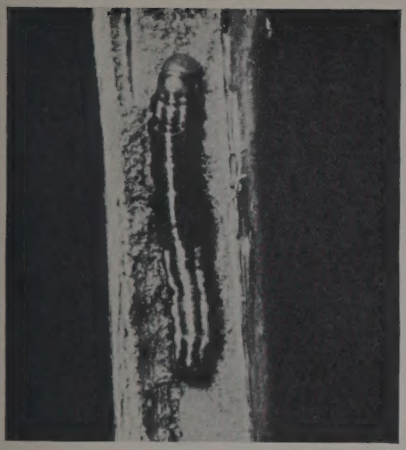

FIGURE 22.—Stalk borer within plant stem.

FIGURE 23.—Fall armyworm feeding on kernels of corn near tip of ear.

and several conspicuous brown or purple stripes running lengthwise of the body. As the stalk borer becomes full grown these bands and stripes disappear, the color becomes plain creamy white or light purple, and the markings are barely visible. The full-grown stalk borer is slightly more than an inch long.

ARMYWORMS

Frequently corn in the ear is seriously damaged by larvae of the fall armyworm [4] burrowing through the husk and feeding on the grain (fig. 23). The true armyworm [5] also attacks corn, sometimes in large numbers, stripping young plants of their leaves. These worms are about 1½ inches long, smooth, striped, and green to brown or almost black.

SMARTWEED BORER

The larva of the smartweed borer [6] is sometimes found in corn during the fall, winter, and spring. This native borer resembles the European corn borer so closely in appearance and work it is very difficult to distinguish between them. The stalk borer usually feeds within the stems of smartweed, and causes little injury to corn.

The larvae of the smartweed borer are about ¾ inch long when full grown. They are slate-colored and bear a very fine, faint, dark line along the middle of the back, decidedly narrower and less conspicuous than the dorsal line on the European corn borer. Otherwise these two kinds of borers can only be distinguished from each other under the microscope.

SOUTHERN CORNSTALK BORER

In the South the southern cornstalk borer [7] is a common enemy of the corn plant. It, too, has the habit of tunneling in the stalks of corn, but it does not bore into the ears and it overwinters only in the roots.

There are two forms of larvae, a summer form and a winter form. The summer form, when full grown, is a dirty-white worm, 1 inch long, covered with many dark spots, each bearing a short, dark bristle, with head and neck shield of brownish

[4] *Laphygma frugiperda.*
[5] *Pseudaletia unipuncta.*
[6] *Pyrausta ainsliei.*
[7] *Diatraea crambidoides.*

yellow. The winter form is a robust creamy-white or yellowish unspotted larva.

OTHER BORERS

Another borer, similar to the southern cornstalk borer, occurs along the Gulf Coast from Florida to the Mexican border. It is the sugarcane borer.[8] Although primarily a pest of sugarcane, this borer readily attacks corn. The larva may be distinguished from the European corn borer larva by its lack of stripes and dark spots.

[8] *Diatraea saccharalis.*

The southwestern corn borer,[9] which also resembles the southern cornstalk borer, occurs in Arizona, New Mexico, Texas, Oklahoma, Kansas, Nebraska, Missouri, Arkansas, and Colorado. Its range overlaps that of the European corn borer in Oklahoma, Kansas, Missouri, and Nebraska. The larvae are not striped, and the spots on the summer form are darker and more prominent than those of the European corn borer. The winter form is a uniform dirty white, and it is usually found in the lowest part of the stalk below the soil surface.

[9] *Diatraea grandiosella.*

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